REFRACTIVE ERRORS



EMMETROPIA

- When parallel rays of light coming from infinity are focused in sensitive layer of retina with accommodation being at rest.
- Components that maintain emmetropization are

axial length

AC depth

corneal curvature



CROSS SECTION OF NORMAL EYE

AMETROPIA

Parallel rays of light coming from infinity (with accommodation at rest) are focused either in front or behind retina.

Further classified into

- Myopia :where the parallel rays of light coming from infinity are focused in front of retina.
- Hypermetropia: where the parallel rays of light are focused behind the sensitive layer of retina.
- Astigmatism :where the refraction varies in different meridia.





Introduction

- Derived from two Greek root words
- (Greek: μυωπία, *muōpia*, from myein "to shut" ops (gen. opos) "eye")
- Myopia or shortsightedness is a type of refractive error in which parallel rays of light coming from infinity are focused in front of retina with the accommodation is at

rest.



ETIOLOGICAL CLASSIFICATION

1. AXIAL MYOPIA

COMMONEST FORM

INCREASE IN ANTERO-POSTERIOR LENGTH OF THE EYEBALL

2. CURVATURAL MYOPIA

INCREASED CURVATURE OF CORNEA, LENS OR BOTH

3. POSITIONAL MYOPIA

PRODUCED BY ANTERIOR PLACEMENT OF CRYSTALLINE LENS IN EYE

4. INDEX MYOPIA

INCREASE IN THE REFRACTIVE INDEX OF CRYSTALLINE LENS ASSOCIATED WITH NUCLEAR SCLEROSIS

5. MYOPIA DUE TO EXCESSIVE ACCOMODATION

SPASM OF ACCOMODATION

CLASSIFICATION OF MYOPIA

According to amount

(Clinical Refraction 3rd edition – Borish)

Classically

- Very low- up to -1.00D
- Low 1.00D to –3.00D
- Medium -3.00D to -6.00 D
- High -6.00D to -10.00D
- Very high above –10.00D



TYPES OF MYOPIA

□ Clinically,

- congenital myopia.
- simple or developmental myopia.
- pathological or degenerative myopia.
- acquired myopia.

Congenital myopia

- □ Present since birth. -Diagnosed by 2-3 years
- Mostly unilateral Manifests as anisometropia
- Seen more frequently in children who were born prematurely or with various birth defects
- Child may develop convergent squint in order to preferentially see clear at its far point (10-12cms)
- May sometimes be associated with other congenital anomalies such as cataract, microphthalmos, aniridia, megalocornea.

Congenital myopia contd..

- Diagnosis
- routine screening
- child viewing objects more close to eyes

 Early correction is desirable to help the children to develop normal distance vision and perception of world.
 Full cycloplegic refractive error including any astigmatic correction should be prescribed.

Simple myopia

- □ Aka physiological or school myopia(8-12yrs).
- Physiological error not associated with any disease of eye.
- Most common variety
- Etiology:

result from normal biological variation in the development of eye.

Simple myopia	etiology
Axial	Physiological variation in the length of the eyeball.
Curvatural	Underdevelopment of eyeball.
Genetics	AD Both 20% Single 10%
	Role of diet in early childhood.
	Theory of excessive near work.

Simple myopia contd...

- Clinical pictures:
 Symptoms:
 - Poor vision for distance.
 - Asthenopic symptoms eye strain due to dissociation between convergence and accommodation.
 - may develop convergence weakness and exophoria and supression in one eye.
 - Change in psychological outlook.





Degree of myopia	Visual acuity
-0.50	6/9-6/12
-1.00	6/18
-1.50	6/24
-2.00	6/36
-3.00	6/60
-4.00	4/60
-5.00	3/60
-6.00	2/60

Simple myopia: SIGNS

Signs

- Prominent eyeballs
- Anterior chamber deeper than normal
- Pupils- Large, sluggishly reacting
- Fundus- normal; rarely temporal myopic crescent may be seen
- Magnitude of refractive error

Increasing at rate -0.5+- 0.30/ year.

Does not exceed 6 to 8

Diagnosis

Confirmed by performing retinoscopy

Pathological myopia

Degenerative/ progressive myopia

- Rapidly progressive error resulting in high myopia usually apparent during 1st decade of life characterized by increase in volume of posterior segment.
- High myopia in early adult life with degenerative changes

□ Etiology:

no satisfactory hypothesis has emerged to explain the etiology of pathological myopia.

Etiology

Role of heredity

- Heredity linked growth of retina is the determinant in developmental myopia
- Sclera due its distensibility follows retinal growth but choroid undergoes degeneration due to stretching, which in turn causes degeneration of retina
- Progressive myopia is
 - Familial
 - More common in chinese, japanese, arabs and jews
 - Uncommon among negroes, nubians and sudanese

• Role of general growth process

Lengthening of the posterior segment of globe commences only during the period of active growth and ends with termination of active growth etiological hypothesis for pathological myopia

Genetic factors General growth (play major role) (Plays minor role) More growth of retina Stretching of sclera Increased axial length Elongation of the eyeball Features of paylopizatical posterior to equator in Degeneration pathological myopia. of choroid

Pathological myopia contd...

- Defective vision
- Muscae volitantes
 - Floating black opacities in front of eyes
- Degenerated liquified vitreous
- Night blindness



are usually harmless.

Pathological myopia contd...

- Signs:
- Eyes are prominent, appearing elongated, and even stimulating an exophthalmos.
- Cornea is large and anterior chamber is deep.
- Pupils are larger
- Refractive error:

increase by as much as 4.00D yearly stabilizes at about the age of 20 but occasionally may progress until mid 30s`` frequently result in myopia of 10-20D

Retinal changes in pathological myopia

Optic disc:

- > appears large and pale
- > at temporal edge a characteristic myopic crescent present.
- Peripapillary crescent encircling the disc may be present, where choroid and retina is distracted away from disc margin
- Super traction crescent may be present on nasal side (retina pulled over disc margin)
- Degenerative changes:
 - in retina and choroid are common.
 - occurs tigroid appearance of fundus due to diffuse attenuation of the RPE with visibility of large choroidalvessels.

Foster- Fuchs spot may be present at macula

It is a raised, circular, pigmented lesion developing after a subretinal haemorrhage has been absorbed .

- In advanced cases there occurs Focal chorio-retinal atrophy which is characterized by visibility of the larger choroidal vessels and eventually the sclera, total retinal atrophy, particularly at central area.
- There may be associated lattice degeneration and or snail track lesions.
- Retinal tears, haemorrhage, retinal detachment may be seen.

- A posterior staphyloma is an ectasia or bulging of the posterior sclera due to focal expansion and thinning .
 - It occurs in about a third of eyes with pathological myopia, and is virtually always peripapillary or involves the macula.Staphyloma development can be associated with macular hole formation.
- Degenerative changes of vitreous include: liquefaction, vitreous opacities, PVD appearing as weiss reflex.





Fundus changes in myopia

The Myopic Fundus











Peripheral retinal degernerations :

A:Lattice degeneration, B:Snail track degeneration C:Acquired retinoschisis D:white-with-pressure E:Focal pigment clumps F:Diffuse chorioretinal degeneration G:Peripheral cystoid degeneration



Choroidal neovascularization associated with a lacquer crack and high myopia.

Visual fields

- Contraction
- Ring scotoma may be seen
- <u>ERG</u> reveals subnormal electroretinogram due to chorioretinal atrophy



Pathological myopia :complications

- Rhegmatogenous retinal detachment (RD) is much more common in high myopia, the pathogenesis including increased frequency of posterior vitreous detachment, lattice degeneration, asymptomatic atrophic holes, macular holes and occasionally giant retinal tears.
- Foveal retinoschisis and macular retinal detachment without macular hole formation may occur in highly myopic eyes with posterior staphyloma, probably as a result of vitreous traction
- Complicated cataract which may be either posterior subcapsular or early onset nuclear sclerotic.
- Vitreous haemorrhages.
- Choroidal haemorrhages and thrombosis.
- Primary open angle glaucoma.

myopia

- Down syndrome
- Stickler syndrome
- Marfan's syndrome
- Prematurity
- Noonan syndrome
- Ehlers–Danlos syndrome
- Pierre–Robin syndrome
- Weill-Marchesani

Ocular Disease associations

- Congenital Glaucoma
- ROP
- RP
- Cataract
- CSNB
- Keratoconus
- Aland eye disease
- Gyrate Atropy
- Pseudomyopia
- Albinism

TREATMENT OF MYOPIA

- Optical treatment
- Surgical treatment
- General measures
- Visual hygiene
- Low-vision aids

Optical treatment

Include prescription of appropriate concave lens. minimum acceptance providing maximum vision should be prescribed.

never overcorrect myopia



Guidelines for correcting low degree of myopia upto -6D

- Children younger than 8yr should be fully corrected and instructed to use their glasses constantly
- Adult younger than 30 yrs:

usually accept their full correction.

Older than 30 yrs:

not able to tolerate a full correction over 3D if they have never worn glasses before.

prescribe less than full correction with which the patient is comfortable.

Guidelines for correcting high myopia

- □ full correction can rarely be tolerated.
- undercorrect as little is compatible with comfort for binocular near vision.
- undercorrection to the tune of 1-3D or even more may be required.
- undercorrection is always better to avoid the problem of near vision and minification of image.

Modes prescribing concave lenses

- Spectacles
- Contact lenses
 - Contact lenses are used in case of high myopia as they avoid peripheral distortion and minification produced by strong concave spectacle lens
HYPERMETROPIA



 The term hypermetropia is derived from hyper meaning "In excess" met meaning "measure" & opia meaning "of the eye".

Also called hyperopia / longsightedness

First suggested in 1755 by KASTNER



DEFINITION

- It is the refractive state of eye where in parallel rays of light coming from infinity are focused behind the sentient layer of retina with accommodation being at rest
- The posterior focal point is behind the retina which receives a blurred image





ETIOLOGY

1) AXIAL

- Most common
- Total refractive power of eye is normal
- Axial shortening of eyeball
- 1mm short- 3 D of HM
- Physiologically more than 6D HM are uncommon
- At birth +2.5 3 D of HM (physiologically)
- Pathologically seen in cases like orbital tumour, inflammatory mass, oedema, coloboma and microphthalmos.



2) CURVATURAL

- Flattening of cornea, lens or both
- 1mm increase in Radius of curvature-RESULTS IN 6D of HM
- Never exceed 6D HM physiologically
- Congenitally flattened (cornea plana)
- Result (trauma and disease)

3) INDEX

- Change in refractive index with age
- Physiologically in old age
- Pathologically in diabetics under treatment



4)POSITIONAL

- Posteriorly placed crystalline lens
- Occurs as congenital anomaly
- Result of trauma or disease

5)ABSENCE OF LENS

Seen in aphakia



CLINICAL TYPES

- SIMPLE HYPERMETROPIA,
- PATHOLOGICAL
- FUNCTIONAL HYPEROPIA



SIMPLE HYPERMETROPIA

- Commonest form
- Results from normal biological variations in the development of eyeball
- Include axial and curvatural HM
- May be hereditary



PATHOLOGICAL HYPERMETROPIA

- Anomalies lie outside the limits of biological variation
- Acquired hypermetropia
 - Decrease curvature of outer lens fibers in old age
 - Cortical sclerosis
- Positional hypermetropia
- Aphakia
- Consecutive hypermetropia



FUNCTIONAL HYPERMETROPIA

Results from paralysis of accommodation

Seen in patients with 3rd nerve paralysis & internal ophthalmoplegia



NOMENCLATURE

TOTAL HYPERMETROPIA= LATENT + MANIFEST (facultative + absolute)



TOTAL HYPERMETROPIA

 It is the total amount of refractive error, estimated after complete cycloplegia with atropine

Divided into latent & manifest



LATENT HYPERMETROPIA

- Corrected by inherent tone of ciliary muscle
- Usually about 1D
- High in children
- Decreases with age
- Revealed after abolishing tone of ciliary muscle with atropine



MANIFEST HYPERMETROPIA

- Remaining part of total hypermetropia
- Correct by accommodation and convex lens
- Measure by add strongest lens with max. vision
- Consists of facultative & absolute FACULTATIVE HYPERMETROPIA
- Corrected by patients accommodative effort ABSOLUTE HYPERMETROPIA
- Residual part not corrected by patients accommodative effort

Absolute hypermetropia can be measured by the weakest convex lens with which maximum visual acuity



NORMAL AGE VARIATION

- At birth +2+3D HM
- Slightly increase in one year of life,
- Gradually diminished untill by the age 5-10 years
 In old age after 50 year again tendency to HM
- Ton of ciliary muscle decreases
- Accommodative power decreases
- Some amount of latent HM become manifest
- More amount of facultative HM become absolute
- Practically after 65 year all of it become absolute



SYMPTOMS

- Principal symptom is blurring of vision for close work
- Symptoms vary depending upon age of patient & degree of refractive error

ASYMPTOMATIC

- small error produces no symptoms
- Corrected by accommodation of patient



ASTHENOPIA

- Refractive error are fully corrected by accommodative effort
- Thus vision is normal
- Sustained accommodation produces symptoms
- Asthenopia increases as day progresses
- Increased after prolonged near work
 SYMPTOMS
 - Tiredness Frontal or fronto temporal headache Watering Mild photophobia



SIGNS

- VISUAL ACUITY : Defective
- EYEBALL: small or normal in size
- **CORNEA** : may be smaller than normal. There can be CORNEA PLANA
- ANTERIOR CHAMBER : may be shallow
- LENS: could be dislocated backwards
- A Scan ultrasonography (biometry) reveal short axial length



FUNDUS:

- B) DISC: Dark reddish color, irregular margins ,confused with Papillitis so termed as PSEUDO-PAPILLITIS
- C) MACULA: Situated further from the disc than usual, large positive angle alpha, apparent divergent squint
- D) BLOOD VESSELS: Show undue tortuosity & abnormal branchings
- E) BACKGROUND: SHOT- SILK RETINA



COMPLICATION

- Recurrent styes m blepharitis or chalazia
- Accommodative convergent squint
- Amblyopia
 - Anisometropic
 - Stravismic
 - Uncorrective bilateral high hypermetropia
- Predisposition to develop primary narrow angle glaucomas

Care should be taken while instilling mydriatics



MODE OF TREATMENT

SPECTACLES

CONTACT LENS

OPTICAL TREATMENT

SURGICAL



SPECTACLES

Basic principle

Prescribe convex lenses(Plus lenses) so that rays are brought to focus on the retina Advantages

- Comfortable
- Easier method
- Less expensive
- Safe idea





Fig. 3.4. Refraction in a hypermetropic eye corrected with convex lens.



ASTIGMATISM

<u>ASTIGMATISM – CURVATURAL AMETROPIA</u>

- It is a type of refractive error wherein the refraction varies in different meridia.
- The rays of light entering the eye cannot converge to a point focus but form focal lines.

Incidence

- Infants: 50% in first year of life -1D
- Adults : 15%>1D & 2% >3D
- Most common compound myopic astigmatism
- With the rule 38%
- Against the rule 30%
- Oblique 32%

OPTICS OF ASTIGMATISM

FIGURE 6.6 Sturm conoid: VV, vertical meridian of refracting surface, more curved than HH, the horizontal meridian; A, B, C, D, E, F, G, sections of conoid; from B to F is the focal interval of Sturm; D shows the circle of least diffusion.



CLASSIFICATION

- Based on etiology
- Based on relation between principal meridians
- Based on orientation of meridian or axis
- Based on focal points relative to the retina



<u>REGULAR ASTIGMATISM</u>

- The astigmatism is regular when the refractive power changes uniformly from one meridian to another .
- Principal meridian are at 90 degree to each other

<u>Etiology :</u>

- 1) Corneal astigmatism congenital abnormal curvature of cornea
- 2) Lenticular astigmatism
 - curvatural (lenticonus)

- positional (tilt or oblique placement of lens, congenital or traumatic subluxation of lens)

- Index astigmatism (variable refractive index of lens in different meridian)

3) Retinal astigmatism – oblique placement of macula

Based on relation between principle meridian

With the rule astigmatism

- In this type two principal meridian are placed at right angle to one another
- the vertical meridian is more curved than the horizontal
- The correction of this astigmatism require concave cylinder at 180° ± 20° or
- Convex cylinder at 90° ± 20°



Against the rule

- In this type of astigmatism, the horizontal meridian is more curved than vertical meridian
- Correction of astigmatism will require concave cylinder at 90° ± 20°
- Convex cylinder at 180° ± 20



Based on orientation of meridian

OBLIQUE ASTIGMATISM

- In this type two principal meridian are not horizontal and vertical, these are at right angles to one another.
- instead of being at 180° and 90°, they are at 45° and 135°.



Bi-oblique astigmatism

- Bi-oblique astigmatism is also a regular astigmatism
- where the two principle meridians are not at right angles and their sum total is not 180°, i.e. one axis is at 100° and the other at 30°.

Based On focal points relative to retina

Simple astigmatism

- One focal point on retina and the other front or behind
- Of 2 types simple myopic and simple hyperopic

Compound astigmatism

- Both the 2 focal points are in front or behind the retina
- Of 2 types compound myopic and hyperopic

Mixed astigmatism

• One focal point in front and other behind the retina

Management

- Optical treatment
- Contact lens
- Surgical management
Optical treatment

- Prescribing appropriate cylindrical lens in the form of spectacles
- Small astigmatism 0.5D should be treated only if it is symptomatic
- High astigmatism full correction to be given
- Adults may not accept full correction undercorrected initially – regular followup – slowly rising power
- Change in axis adult patient poorly tolerated
- New astigmatic correction adult pt produce intolerable distraction



Figure 6.20: Classification of astigmatism. *The value of the cylinder will be more than the value of the sphere.

<u>CONTACT LENS</u>

- Toric soft contact lens
- Rigid gas permeable lens
- Bi oblique astigmatism, mixed astigmatism, high astigmatism are better treated by contact lens.

<u>Surgical management</u>



Figure 11.12: Refractive procedures for astigmatism

